

Contents

1 The body

What is anatomy? 2

- How can gross anatomy be studied? 2
- Important anatomical terms 2

Imaging 5

- Diagnostic imaging techniques 5
- Nuclear medicine imaging 8

Image interpretation 10

- Plain radiography 10
- Computed tomography 11
- Magnetic resonance imaging 11
- Nuclear medicine imaging 11

Safety in imaging 11

Body systems 12

Skeletal system 12

- Cartilage 12
- Bone 13
- Joints 17

Skin and fascias 23

- Skin 23
- Fascia 23

Muscular system 23

Cardiovascular system 25

Lymphatic system 27

- Lymphatic vessels 27
- Lymph nodes 28
- Lymphatic trunks and ducts 28

Nervous system 29

- Central nervous system 29
- Functional subdivisions of the CNS 30
 - Somatic part of the nervous system 31
 - Visceral part of the nervous system 34

Other systems 46

Clinical case 48

2 Back

Conceptual overview 51

General description 51

Functions 52

- Support 52
- Movement 52
- Protection of the nervous system 53

Component parts 54

- Bones 54
- Muscles 55
- Vertebral canal 57
- Spinal nerves 58

Relationship to other regions 59

- Head 59
- Thorax, abdomen, and pelvis 60
- Limbs 60

Key features 60

- Long vertebral column and short spinal cord 60
- Intervertebral foramina and spinal nerves 61
- Innervation of the back 61

Regional anatomy 62

Skeletal framework 62

- Vertebrae 62
- Intervertebral foramina 70
- Posterior spaces between vertebral arches 71

Joints 78

- Joints between vertebrae in the back 78

Ligaments 81

- Anterior and posterior longitudinal ligaments 81
- Ligamenta flava 81
- Supraspinous ligament and ligamentum nuchae 81
- Interspinous ligaments 82

Back musculature 86

- Superficial group of back muscles 86
- Intermediate group of back muscles 92
- Deep group of back muscles 94
- Suboccipital muscles 99

Spinal cord 101

- Vasculature 102
- Meninges 106
- Arrangement of structures in the vertebral canal 107
- Spinal nerves 109

Surface anatomy 114

- Back surface anatomy 114
- Absence of lateral curvatures 114
- Primary and secondary curvatures in the sagittal plane 115
- Useful nonvertebral skeletal landmarks 115
- How to identify specific vertebral spinous processes 117
- Visualizing the inferior ends of the spinal cord and subarachnoid space 118
- Identifying major muscles 119

Clinical cases 121

3 Thorax

Conceptual overview 125

General description 125

Functions 126

Breathing 126

Protection of vital organs 126

Conduit 126

Component parts 126

Thoracic wall 126

Superior thoracic aperture 128

Inferior thoracic aperture 128

Diaphragm 129

Mediastinum 130

Pleural cavities 130

Relationship to other regions 132

Neck 132

Upper limb 132

Abdomen 132

Breast 133

Key features 134

Vertebral level TIV/V 134

Venous shunts from left to right 134

Segmental neurovascular supply of thoracic wall 136

Sympathetic system 138

Flexible wall and inferior thoracic aperture 138

Innervation of the diaphragm 139

Regional anatomy 140

Pectoral region 140

Breast 140

Muscles of the pectoral region 143

Thoracic wall 144

Skeletal framework 144

Intercostal spaces 151

Diaphragm 163

Arterial supply 164

Venous drainage 164

Innervation 164

Movements of the thoracic wall and diaphragm during breathing 164

Pleural cavities 166

Pleura 166

Lungs 170

Mediastinum 184

Anterior mediastinum 184

Middle mediastinum 185

Superior mediastinum 215

Posterior mediastinum 227

Surface anatomy 236

Thorax surface anatomy 236

How to count ribs 236

Surface anatomy of the breast in women 237

Visualizing structures at the TIV/V vertebral level 237

Visualizing structures in the superior mediastinum 238

Visualizing the margins of the heart 239

Where to listen for heart sounds 240

Visualizing the pleural cavities and lungs, pleural recesses, and lung lobes and fissures 240

Where to listen for lung sounds 242

Clinical cases 244

4 Abdomen

Conceptual overview 251

General description 251

Functions 252

Houses and protects major viscera 252

Breathing 254

Changes in intraabdominal pressure 254

Component parts 255

Wall 255

Abdominal cavity 256

Inferior thoracic aperture 258

Diaphragm 258

Pelvic inlet 259

Relationship to other regions 259

Thorax 259

Pelvis 259

Lower limb 260

Key features 261

Arrangement of abdominal viscera in the adult 261

Skin and muscles of the anterior and lateral abdominal wall and thoracic intercostal nerves 264

The groin is a weak area in the anterior abdominal wall 265

Vertebral level LI 267

The gastrointestinal system and its derivatives are supplied by three major arteries 267

Venous shunts from left to right 269

All venous drainage from the gastrointestinal system passes through the liver 270

Abdominal viscera are supplied by a large prevertebral plexus 272

Regional anatomy 273

Surface topography 273

Four-quadrant pattern 273

Nine-region pattern 274

Abdominal wall 276

Superficial fascia 276

Anterolateral muscles 278

Extraperitoneal fascia 284

Peritoneum 284

Innervation 285

Arterial supply and venous drainage 287
Lymphatic drainage 288

Groin 288

Inguinal canal 290
Inguinal hernias 296

Abdominal viscera 300

Peritoneum 300
Peritoneal cavity 301
Organs 307
Arterial supply 343
Venous drainage 354
Lymphatics 358
Innervation 358

Posterior abdominal region 366

Posterior abdominal wall 367
Viscera 374
Vasculature 387
Lymphatic system 392
Nervous system in the posterior abdominal region 394
Sympathetic trunks and splanchnic nerves 394

Surface anatomy 402

Abdomen surface anatomy 402
Defining the surface projection of the abdomen 402
How to find the superficial inguinal ring 403
How to determine lumbar vertebral levels 404
Visualizing structures at the L1 vertebral level 405
Visualizing the position of major blood vessels 406
Using abdominal quadrants to locate major viscera 407
Defining surface regions to which pain from the gut is referred 408
Where to find the kidneys 409
Where to find the spleen 409

Clinical cases 410

5 Pelvis and perineum

Conceptual overview 415

General description 415

Functions 415

Contains and supports the bladder, rectum, anal canal, and reproductive tracts 415
Anchors the roots of the external genitalia 417

Component parts 418

Pelvic inlet 418
Pelvic walls 418
Pelvic outlet 420
Pelvic floor 421
Pelvic cavity 421
Perineum 422

Relationship to other regions 424

Abdomen 424
Lower limb 425

Key features 426

The pelvic cavity projects posteriorly 426
Important structures cross the ureters in the pelvic cavity 427
The prostate in men and the uterus in women are anterior to the rectum 428
The perineum is innervated by sacral spinal cord segments 428
Nerves are related to bone 429
Parasympathetic innervation from spinal cord levels S2 to S4 controls erection 430
Muscles and fascia of the pelvic floor and perineum intersect at the perineal body 431
The course of the urethra is different in men and women 432

Regional anatomy 433

Pelvis 433

Bones 433
Joints 438
Orientation 440
Differences between men and women 440
True pelvis 441
Viscera 452
Fascia 475
Peritoneum 475
Nerves 480
Blood vessels 489
Lymphatics 495

Perineum 496

Borders and ceiling 496
Ischio-anal fossae and their anterior recesses 498
Anal triangle 498
Urogenital triangle 500
Somatic nerves 508
Visceral nerves 510
Blood vessels 511
Veins 511
Lymphatics 514

Surface anatomy 515

Surface anatomy of the pelvis and perineum 515
Orientation of the pelvis and perineum in the anatomical position 515
How to define the margins of the perineum 515
Identification of structures in the anal triangle 517
Identification of structures in the urogenital triangle of women 518
Identification of structures in the urogenital triangle of men 519

Clinical cases 522

6 Lower limb

Conceptual overview 527

General introduction 527

Function 529

Support the body weight 529

Locomotion 529

Component parts 531

Bones and joints 531

Muscles 535

Relationship to other regions 537

Abdomen 537

Pelvis 537

Perineum 537

Key points 537

Innervation is by lumbar and sacral spinal nerves 537

Nerves related to bone 542

Superficial veins 542

Regional anatomy 543

Bony pelvis 543

Proximal femur 546

Hip joint 550

Gateways to the lower limb 554

Nerves 555

Arteries 558

Veins 560

Lymphatics 562

Deep fascia and the saphenous opening 563

Femoral triangle 564

Gluteal region 566

Muscles 566

Nerves 571

Arteries 574

Veins 575

Lymphatics 575

Thigh 575

Bones 576

Muscles 581

Arteries 592

Veins 595

Nerves 595

Knee joint 598

Tibiofibular joint 609

Popliteal fossa 609

Leg 612

Bones 612

Joints 614

Posterior compartment of leg 615

Lateral compartment of leg 622

Anterior compartment of leg 624

Foot 627

Bones 629

Joints 633

Tarsal tunnel, retinacula, and arrangement of major structures at the ankle 642

Arches of the foot 644

Plantar aponeurosis 645

Fibrous sheaths of toes 645

Extensor hoods 646

Intrinsic muscles 646

Arteries 653

Veins 655

Nerves 655

Surface anatomy 659

Lower limb surface anatomy 659

Avoiding the sciatic nerve 659

Finding the femoral artery in the femoral triangle 660

Identifying structures around the knee 660

Visualizing the contents of the popliteal fossa 662

Finding the tarsal tunnel—the gateway to the foot 663

Identifying tendons around the ankle and in the foot 664

Finding the dorsalis pedis artery 665

Approximating the position of the plantar arterial arch 665

Major superficial veins 666

Pulse points 667

Clinical cases 668

7 Upper limb

Conceptual overview 673

General description 673

Functions 674

Positioning the hand 674

The hand as a mechanical tool 677

The hand as a sensory tool 677

Component parts 678

Bones and joints 678

Muscles 680

Relationship to other regions 681

Neck 681

Back and thoracic wall 682

Key points 683

Innervation by cervical and upper thoracic nerves 683

Nerves related to bone 687

Superficial veins 688

Orientation of the thumb 689

Regional anatomy 690

Shoulder 690

Bones 690

Joints 693

Muscles 702

Posterior scapular region 705

- Muscles 706
- Gateways to the posterior scapular region 706
- Nerves 708
- Arteries and veins 708

Axilla 710

- Axillary inlet 712
- Anterior wall 712
- Medial wall 715
- Lateral wall 716
- Posterior wall 717
- Gateways in the posterior wall 719
- Floor 720
- Contents of the axilla 720

Arm 739

- Bones 740
- Muscles 743
- Arteries and veins 745
- Nerves 749

Elbow joint 753

Cubital fossa 758

Forearm 761

- Bones 763
- Joints 764

Anterior compartment of the forearm 766

- Muscles 766
- Arteries and veins 772
- Nerves 774

Posterior compartment of the forearm 775

- Muscles 775
- Arteries and veins 781
- Nerves 782

Hand 782

- Bones 783
- Joints 785
- Carpal tunnel and structures at the wrist 788
- Palmar aponeurosis 791
- Palmaris brevis 791
- Anatomical snuffbox 791
- Fibrous digital sheaths 792
- Extensor hoods 793
- Muscles 795
- Arteries and veins 801
- Nerves 805

Surface anatomy 810

- Upper limb surface anatomy 810
- Bony landmarks and muscles of the posterior scapular region 810
- Visualizing the axilla and locating contents and related structures 811
- Locating the brachial artery in the arm 812
- The triceps brachii tendon and position of the radial nerve 813

- Cubital fossa (anterior view) 813
- Identifying tendons and locating major vessels and nerves in the distal forearm 815
- Normal appearance of the hand 816
- Position of the flexor retinaculum and the recurrent branch of the median nerve 817
- Motor function of the median and ulnar nerves in the hand 817
- Visualizing the positions of the superficial and deep palmar arches 818
- Pulse points 818

Clinical cases 820

8 **Head and neck**

Conceptual overview 825

General description 825

- Head 825
- Neck 827

Functions 829

- Protection 829
- Contains upper parts of respiratory and digestive tracts 829
- Communication 829
- Positioning the head 829
- Connects the upper and lower respiratory and digestive tracts 829

Component parts 830

- Skull 830
- Cervical vertebrae 832
- Hyoid bone 833
- Soft palate 834
- Muscles 834

Relationship to other regions 835

- Thorax 835
- Upper limbs 835

Key features 836

- Vertebral levels CIII/IV and CV/VI 836
- Airway in the neck 837
- Cranial nerves 838
- Cervical nerves 839
- Functional separation of the digestive and respiratory passages 839
- Triangles of the neck 842

Regional anatomy 843

Skull 843

- Anterior view 843
- Lateral view 845

- Posterior view 847
- Superior view 848
- Inferior view 848

Cranial cavity 852

- Roof 852
- Floor 853

Meninges 861

- Cranial dura mater 861
- Arachnoid mater 864
- Pia mater 865
- Arrangement of meninges and spaces 865

Brain and its blood supply 867

- Brain 867
- Blood supply 868
- Venous drainage 874

Cranial nerves 883

- Olfactory nerve [I] 885
- Optic nerve [II] 885
- Oculomotor nerve [III] 886
- Trochlear nerve [IV] 886
- Trigeminal nerve [V] 887
- Ophthalmic nerve [V₁] 887
- Maxillary nerve [V₂] 887
- Mandibular nerve [V₃] 887
- Abducent nerve [VI] 887
- Facial nerve [VII] 887
- Vestibulocochlear nerve [VIII] 888
- Glossopharyngeal nerve [IX] 888
- Vagus nerve [X] 892
- Accessory nerve [XI] 892
- Hypoglossal nerve [XII] 892

Face 893

- Muscles 893
- Parotid gland 900
- Innervation 903
- Vessels 905

Scalp 911

- Layers 911
- Innervation 913
- Vessels 914
- Lymphatic drainage 915

Orbit 916

- Bony orbit 916
- Eyelids 917
- Lacrimal apparatus 921
- Fissures and foramina 923
- Fascial specializations 924
- Muscles 925
- Vessels 931
- Innervation 932
- Eyeball 936

Ear 942

- External ear 943
- Middle ear 947
- Internal ear 954

Temporal and infratemporal fossae 961

- Bony framework 962
- Temporomandibular joints 964
- Masseter muscle 966
- Temporal fossa 967
- Infratemporal fossa 970

Pterygopalatine fossa 981

- Skeletal framework 982
- Gateways 983
- Contents 983

Neck 989

- Fascia 989
- Superficial venous drainage 992
- Anterior triangle of the neck 995
- Posterior triangle of the neck 1012
- Root of the neck 1019

Pharynx 1029

- Skeletal framework 1030
- Pharyngeal wall 1031
- Fascia 1034
- Gaps in the pharyngeal wall and structures passing through them 1035
- Nasopharynx 1035
- Oropharynx 1037
- Laryngopharynx 1037
- Tonsils 1037
- Vessels 1038
- Nerves 1040

Larynx 1041

- Laryngeal cartilages 1042
- Extrinsic ligaments 1045
- Intrinsic ligaments 1046
- Laryngeal joints 1047
- Cavity of the larynx 1048
- Intrinsic muscles 1050
- Function of the larynx 1053
- Vessels 1055
- Nerves 1057

Nasal cavities 1058

- Lateral wall 1059
- Regions 1060
- Innervation and blood supply 1061
- Skeletal framework 1061
- External nose 1063
- Paranasal sinuses 1063
- Walls, floor, and roof 1065
- Nares 1069

Choanae 1070
Gateways 1071
Vessels 1071
Innervation 1074

Oral cavity 1076

Multiple nerves innervate the oral cavity 1077
Skeletal framework 1077
Walls: the cheeks 1080
Floor 1081
Tongue 1084
Salivary glands 1091
Roof—palate 1095
Oral fissure and lips 1103
Oropharyngeal isthmus 1104
Teeth and gingivae 1104

Surface anatomy 1110

Head and neck surface anatomy 1110
Anatomical position of the head and major landmarks 1110
Visualizing structures at the CIII/CIV and CVI vertebral levels 1111
How to outline the anterior and posterior triangles of the neck 1112
How to locate the cricothyroid ligament 1113
How to find the thyroid gland 1114
Estimating the position of the middle meningeal artery 1114
Major features of the face 1115
The eye and lacrimal apparatus 1116
External ear 1117
Pulse points 1118

Clinical cases 1119

e-9

Neuroanatomy

Part I: Nervous system overview

Development
Terms of orientation
Cellular components
Nervous system functional organization

Part II: Brain

Cerebral hemispheres
Ventricular system
Meninges
Cerebral vasculature
Venous drainage

Part III: Thalamus

Part IV: Brainstem

Overview
External midbrain
External pons
External medulla oblongata
Brainstem internal features
Internal midbrain
Internal pons
Internal medulla oblongata
Vascular supply to the brainstem

Part V: Spinal cord

Overview
Spinal meninges
External features
Internal features
Ascending tracts in the spinal cord
Descending tracts in the spinal cord
Vascular supply to the spinal cord

Part VI: Basal nuclei

Corpus striatum
Connections of the basal nuclei

Part VII: Cerebellum

Structures of the cerebellum
Afferent cerebellar pathways
Efferent cerebellar pathways
Vascular supply

Part VIII: Visual system

Central visual pathway

Part IX: Auditory and vestibular system

Auditory pathways
Cochlea
Central auditory pathways
Vestibular pathways

Part X: Hypothalamus

Borders of the hypothalamus
Connections to the pituitary
Functional divisions of the hypothalamus
Summary of connections

Part XI: Olfactory and limbic system

Olfactory system
Limbic system